Paper Number

Targeted MRM Programs: Setting ROI Goals and Measuring the Results

Manoj S. Patankar
San Jose State University

James C. Taylor
Santa Clara University

ABSTRACT

MRM programs have impacted several operational and safety issues. However, many of these programs did not target a particular safety or performance goal by design. Consequently, MRM champions have had difficulty in presenting financial justification for the continuation of their programs. This paper presents a model that accounts for extraneous influences on the performance/safety changes while distilling the specific effects of MRM training or other interventions on the corporate bottom-line. It also presents a case for strategic implementation of MRM programs with specific ROI goals.

INTRODUCTION

Maintenance Resource Management (MRM) programs have had numerous different impacts on operations and safety in the aviation industry. Awareness training programs at several airlines demonstrated an increase in the employee awareness of, and enthusiasm for, safety issues, reduction in ground damage incidents, reduction in logbook errors, and openness to other performance enhancements (Taylor & Christensen, 1998 Ch. 9 & 10). Behavior training programs at some corporate aviation departments have shown an increase in the pilot-technician communication, improvements in technical support from third-party service providers, and better cooperation with the local FSDO (Patankar & Taylor, 1999). So, there is enough data to demonstrate that MRM programs are successful; yet, this "success" is illusive because a specific MRM program may not necessarily result in the same improvements at all sites. This paper presents a model that could be used to measure the success of the extant or past awareness training. It also presents a case for strategic implementation of MRM programs with specific ROI goals.

MRM INFRASTRUCTURE

Several guidance documents such as the FAA Human Factors Guide (1998) the ATA Spec 113 (ATA, 1999), and the FAA MRM Handbook (1999) are now available for the developers of new MRM programs. Often enthusiastic MRM program developers tend to start designing training programs without a thorough consideration to their MRM plan. Consequently, the continuation of such programs is dependent on individual motivation rather than collective or organizational commitment. To help the future MRM developers, the authors suggest the following infrastructure items.

A. HUMAN RESOURCES MASTER PLAN

Patankar and Taylor (In Press) have recommended that a Human Resources Integration Master Plan be developed. This recommendation is based on ATA Spec 113 guidelines and the authors' research on the reasons for the lack of implementation of maintenance human factors principles in the U.S. airline industry. The authors conclude that formulation of such a document will make the top corporate management and local MRM champions more accountable to each other and to their commitment to human factors programs. With this joint commitment to purpose, these programs will not be in a state of flux when there is a management change.

B. TRAINER AND CURRICULA

Trainers and the curricula form a critical part of the MRM program. Currently, classroom instruction offered by most of the airlines is mistakenly referred to as MRM training. The authors find it important to defer on this terminology and call it MRM instruction because according to the Webster's Dictionary (1983), "to train" is to "make proficient by instruction and practice." Since the airline "training" does not include the practice component

at this time, it must be called MRM instruction. To illustrate the importance of follow-up practice or skills training, it will be worthwhile to compare the MRM instruction with technical training. Classroom technical courses are usually supplemented by formal or informal On-the-Job-Training (OJT). There, the trainers recognize that the theory is not enough; the students need some on-site help and guidance in order for them to apply their knowledge at an acceptable performance level. However, with regard to the MRM course, the classroom instruction has not yet been adequately supplemented by any OJT. Taylor and Christensen (1998) have found that the awareness "training" programs are very successful in raising the awareness of safety issues, but this awareness does not necessarily translate into the anticipated behavior change. Technicians tend to make a few changes that are within their span of control and then wait for others to follow or for the management to make the systemic changes. Many airline programs have stalled at this point. From a curricular perspective, several reference materials, including computer based training programs and videos, are now available. The developers must bear in mind their program goals prior to selecting and finalizing the curricula. This is especially important when the developers must provide a somewhat different training to management. Management personnel will be involved in addressing the safety concerns brought forth by the technicians and so they may have to be pre-trained on how to handle such concerns.

C. PRODUCT CHAMPIONS

Most of the airlines that have a human factors program have several key people who champion the theory and practice of human factors. Often, these champions include local management, trade union leaders, and company educators. Top management is sometimes an active champion, but this is rare. Cooperation of both the labor union(s) and all levels of management is crucial. Additionally, Eiff's (1999) research shows that the first-line supervisors, such as the Lead Mechanics and Foremen, are the most influential people in affecting technician behavior. Therefore, it will be beneficial to seek appropriate Leads and Foremen to champion the implementation of MRM principles.

D. ERROR DATA MANAGEMENT PROGRAMS

Error data management programs are perhaps one of the most difficult programs to implement. When trainers do an excellent job of making the technicians more aware of the terms like "Dirty Dozen" and "Links of a Chain," the technicians are likely to be anxious to start looking for errors. If appropriate error data management programs are not established, the technicians will eventually lose their enthusiasm. Two processes that may be considered are the Aviation Safety Action Program (FAA, 1997b) and the Aviation Safety Reporting System (FAA, 1997c). These programs are aimed at collecting valuable safety data that would not be obtainable otherwise. The intent is to resolve systemic errors before they cause accidents; but, the separate issues of confidentiality, error awareness and discovery, and amnesty as an incentive seem to cause additional problems with these programs. If an appropriate program is selected and the problematic issues are solved in advance, the participants could be trained in using the chosen reporting systems.

E. ERROR REDUCTION POLICIES AND PROCEDURES

These are the programs that are intended to eliminate or reduce poor decisions which lead to errors—in other words, stopping an error before it starts. Error Reduction Policies and Procedures may be primarily based upon the notion of conflict resolution. For such application, "conflict" is defined as a simple disagreement or discrepancy among two seemingly consistent data sources. The situations are not limited to or focused on, interpersonal conflict. For example, when data in a maintenance manual is not consistent with the data in a job card, a conflict exists. Also, when two established work norms are not consistent, a conflict exists. Structured and standardized policies and procedures must be used to resolve all conflicts.

F. ONGOING EVALUATION

The MRM program as a whole, not just training effectiveness, must be evaluated against the initial goals, objectives, and financial impact.

SOME MRM TARGETS

A. SYSTEMIC STRATEGY

Once the goals and objectives of the MRM program have been delineated, the developers must consider whether there will be any differences in the content/timelines for training to managers, technicians, inspectors, ground handlers, stores personnel, and utility. If the same content is delivered to the entire population, in a mixed classroom environment, the advantage is that these interdependent professionals would have the opportunity to understand each other's roles and

responsibilities. On the other hand, there is also a possibility that the management personnel may not feel comfortable when they are confronted with floor problems, or the technicians may not want the utility personnel to have the same kind of training, or the non-technical personnel may think that the training was not applicable to their work. If the content is customized to each occupation, it may need substantially longer development time and delivery resources. There are several different possibilities; however, both the desired outcomes as well as the probable ones need to be assessed in advance.

B. AWARENESS

Many airlines have initiated their MRM programs with awareness instruction. Such instruction is very useful in providing the maintenance community with a common language regarding the human factors concepts. Several studies have shown that awareness instruction programs have been successful in educating the participants regarding the safety issues, and these participants were enthusiastic about wanting to apply this instruction in their work environment. The problem with awareness instruction is that it is just an awareness instruction; however much, the airlines may expect such programs to automatically effect a behavior change and improve safety. This is an unreasonable expectation. If an airline intends to provide awareness instruction, it should not expect more than a heightened awareness and a readiness to apply the theoretical concepts as the outcomes.

C. ACTIVE ERROR REDUCTION SKILLS

These are the skills that will help the individuals apply the human factors principles to their respective work environments. Examples of such skills include assertiveness, teamwork, conflict resolution, cooperative risk assessment, behavior modeling, and safety in personal life. Awareness instruction is very helpful in alerting the individual to the operational risks, but it does not provide much practical assistance in managing these risks. If an airline is able to provide practical skills training, such as that presented in the AMT-T Team Training CD-ROM (FAA, 1997a), the safety climate of that airline is likely to improve substantially. Consider a technical training course like sheet metal repair. Even after completing this course, the technician is not likely to be released to perform sheet metal repair on airworthy aircraft on his/her own. Most likely, a senior technician is likely to be assigned to guide this technician in applying the newly acquired knowledge. In the case of MRM training, the practical, on-the-job guidance needs to be provided through appropriate skills training. The authors suggest that positive goals like the “number of errors avoided” or “number of information discrepancies resolved” be used as celebration milestones. Such goals, instead of the conventional “accident-free days”, will stimulate an enthusiastic environment wherein people want to actively reduce errors. The conventional sign stating the number of days without an accident simply creates suspense as to when the next one is going to strike because absence of accident does not mean presence of safety.

D. LOCAL PROBLEMS-LOCAL SOLUTIONS

Some of the problems that MRM programs have solved are as follows: documentation errors, communication problems in a shift turnover, logbook errors, and maintenance procedural errors (Taylor & Christensen, 1998 Ch. 9). If an airline is able to identify one specific problem at a specific station or hangar, appropriate MRM intervention could be developed. For example, if an airline identifies runway incursions as a significant problem at a line station, the local technicians could be trained to use MRM principles to avoid runway incursions. When problems are identified so specifically, the management will be able to track the success of the intervention and the technician will feel that they are receiving real help from the management.

E. ASAP/ASRS VOLUNTARY DISCLOSURE PROGRAM

Aviation Safety Action Program or the Aviation Safety Reporting System could be used to develop a voluntary reporting and problem solving culture that is non-punitive, equitable, and trustworthy. Some airlines are striving toward such a culture because they want to learn about the organizational errors and rectify them prior to a consequential accident. In one case, an airline used “roundtable discussions” to create systemic “fixes” of errors disclosed by either the company, the mechanics’ trade union, or the local FAA (Taylor & Christensen, 1998). Two other options exist as current FAA policy: one is by the way of an ASAP agreement with the FAA and the other is through the NASA-operated ASRS program. The discussion regarding the relative viability of such programs is beyond the scope of this paper. However, the authors encourage MRM developers to consider these programs in their human resources master plan (see Patankar & Taylor, In Press).

ROI FROM CLASSROOM INSTRUCTION ONLY

Generally, the MRM programs at most airlines have been limited to classroom instruction. Such instruction has caused some attitudinal change followed

by a limited behavioral change. But, to measure the return-on-investment (ROI) from such classroom instruction has been difficult because several concurrent efforts may have led to the overall improvements in safety, not necessarily the instruction. Therefore, Taylor (In Press) presents a formula that accounts for the concurrent safety initiatives and distills the effects of classroom instruction for a realistic assessment of return on investment from instruction alone.

Phillips (1997) expanded Kirkpatrick's four levels of evaluating training effectiveness to include return on investment. Taylor (In Press) incorporated these earlier approaches to evaluation and added to his ROI equation a measurable relationship between the changes in behavior and improvements in safety and productivity. Since the classroom instruction is the only cost factor, the changes in the behavior resulting in safety and productivity changes are benefits. Taylor correlated Lost Time Injury data for 30 months with his pre- and post-training MRM/TOQ data. He used this correlation as the Causal Operator or the relative claim toward the overall improvements in safety. Therefore, in one of his examples, if the cost of MRM instruction was $251,660 and the saving in Lost Time Injury was $1,314,150, the net benefit was $1, 062, 490. The resulting return on investment was 24 percent.

ROI FROM SPECIFIC INTERVENTIONS

Specific interventions such as roundtable discussions and small group forums to improve logbook documentation (Taylor & Christensen, 1998 Ch. 9) and on-the-job assistance to improve shift turnover briefings (Eiff, 1999) have resulted in some very impressive benefits. Such interventions go beyond the classroom instruction and actually help the participants solve their extant problems using the human factors principles. Eiff mapped the communication processes during shift turnovers at a heavy maintenance facility of a major U. S. airline. He discovered that the Lead Mechanics were the hubs of these communications, but they did not participate in shift briefings. Eiff used a team of four mechanics, four leads, two shift managers, two academic faculty, and three students to compile the shift communication information, cross-check it with the corresponding job descriptions, and develop a new shift turnover process. Eiff's team trained one maintenance bay in using the new procedures and measured their effectiveness. Eiff's results show that after the first aircraft, 58 percent of the people were satisfied with the new shift turnover process and there was an associated decrease in lost productivity from 64 hours to 11 hours. After the second aircraft, 65 percent of the people were satisfied with the new shift turnover process and there was an associated decrease in productivity from the initial 64 hours to 0 hours. In general, Eiff's team was successful in saving $140,000 per aircraft.

RUBBER-BAND EFFECT

Taylor and Christensen's research (1998) shows that the enthusiasm for MRM training lasts for about 6-9 months. If the employees don't see any evidence of the airline's willingness to implement the MRM principles, they tend to lose their enthusiasm and under extreme conditions (such as labor disputes) may even turn negative. An MRM program, mostly in its very limited form – training only, is often incorrectly considered a one-time solution. In such cases, it will result in a rubber-band effect in which a rubber band can be stretched, but will return to its original size: the results are only temporary.

Organizational commitment, stronger than the temporal economic challenges, is crucial to effect a long-term change from MRM programs.

A CASE FOR STRATEGIC IMPLEMENTATION OF MRM PROGRAMS

National Aeronautics and Space Administration, under the auspices of the Aviation Safety Reporting System, operates the Aviation Safety Reporting System. Pilots, mechanics, air traffic controllers, and other users of the National Airspace System can report to NASA actual or potential discrepancies and deficiencies involved in the safety of aviation operations. Information acquired through this system is de-identified and can not be used by the FAA to bring legal or administrative action against the reporter. The authors have used one such ASRS report filed by a mechanic to illustrate how strategic implementation of MRM programs could solve systemic or organizational problems.

ASRS REPORT 421402

"I [an aircraft mechanic] worked on a Job Card to install fan blades on #2 engine of aircraft XYZ. My part of the job was to check that the fan blade dampers, spacers, retainers, and blades were installed correctly. I also installed the rear and front spinner cones. On Nov/XY/98, this aircraft developed an engine vibration. The blades were removed and upon removal found all 38 aircraft XYZ blade dampers incorrectly installed. My signoff on the job only permitted me to see the front of the blades and dampers as they were all installed with retainers and spacers. I believe to the best of my knowledge that the dampers were installed per the job card in question." Callback conversation with the reporter revealed the following information: "The reporter states that the engine fan retention installation was checked by the reporter after

the installation was accomplished by another mechanic. The reporter said that the check is made looking at the face of the fan disk and only looking at the end of the parts which would not reveal any incorrect damper installation. The reporter stated the job card to install the dampers has no drawings or visual aids to prevent the incorrect installations but the maintenance manual has clear instructions and good visual aids. The maintenance manual was not used in this case."

ANALYSIS

Clearly, in the above case it was a human factors issue. The authors classify the above incident as an organizational problem because another mechanic would have also been set-up to commit the same mistake, under the same circumstances. It was not an issue where the individual failed to follow the acceptable/approved procedure. This incident also identifies a specific target area for MRM implementation. In this case, there is a discrepancy between the data in the job card and the maintenance manual that resulted in the return of a flight. It is quite likely the same installation error has occurred in the past. If the cost of that error (including fuel cost, crew time, departure/arrival slot cost, maintenance labor and parts, and cost of revising the job card) is calculated and the trend of mid-flight returns is projected, it will be possible to calculate the cost of that incident. Then, considering the MRM intervention, either through classroom instruction or via specific OJT on how to get the job card revised, the return on investment may be calculated.

STRATEGIC IMPLEMENTATION

The authors recommend strategic implementation of an MRM programs to include (a) awareness instruction, (b) active error reduction skills training, (c) targeted interventions, and (d) ASRS, ASAP, or "Roundtables" for maintenance. Each of the above steps should have measurable goals. Since many airlines have either started or already completed their awareness instruction, it will be advisable to consider that as the first level of MRM implementation. At this level, the main goal should be to inform the general population of the MRM issues and present the terminology. A reasonable level of attitudinal change could be expected.

To effect a measurable behavior change, the airlines must consider the next level of MRM: active error reduction skills training. At this level, it is essential that the organization tap the already heightened level of awareness to teach specific skills such as interpersonal communication, conflict resolution, and application of human factors principles. At this level, the developers should expect a behavioral change. This change could be tracked using parameters such as information conflicts resolved, documentation changes, re-worked maintenance items, ground damage incidents, etc. Then, at the third level, it will be essential to identify a few key, high-visibility areas such as ground damage or runway incursions. Once these areas are identified, the developers could help the maintenance personnel develop appropriate solutions: local solutions for local problems. Once several of these targeted approaches are successful, the airline may be ready for the fourth level--a formal voluntary disclosure program--that would help them identify additional, normally unreported incidents that may lead to reportable incidents or catastrophic failures. These four levels acknowledge that MRM implementation is a long-term project and the returns on MRM investment could come from a variety of targets.

CONCLUSIONS

It is never too early or too late to target MRM programs to achieve specific objectives. Companies that have developed specific MRM targets, must also develop the corresponding measurement tools and techniques. It is best to develop the measurement system concurrent with the strategic plan. For those companies that have not started their MRM programs yet, it will be best to have the strategic goals and evaluation criteria established prior to launching their MRM program. For those companies that have already delivered their MRM "training," the next step would be to set specific performance/safety goals, develop strategies to accomplish those goals, and then to achieve those goals. Irrespective of the type of MRM program implemented, there is a positive effect on the safety/performance of that company. It is hoped that the senior management will find targeted MRM programs easier to support.

ACKNOWLEDGEMENTS

Part of this research was funded through NASA award #NCC2-1025 to Santa Clara University, as part of a cooperative research program between the Federal Aviation Administration Office of Aviation Medicine (FAA/AAM-240) and NASA Ames Research Center.

CONTACT

Manoj S. Patankar
San Jose State University
One Washington Square
San Jose, CA 95192-0081
Telephone: 408-924-6595

REFERENCES

1. (1998). *Aviation Human Factors Guide v3.0.* Washington, D.C.: Federal Aviation Administration.
2. (1999). *FAA Maintenance Resource Management Handbook.* Washington, D.C.: Federal Aviation Administration.
3. ATA (1999). *ATA SPEC 113: Maintenance Human Factors Program Guidelines*. www.air-transport.org/public/publications/57.asp.
4. Eiff, G. (1999). *Human factors: safety and productivity equation, and return on investment.* Paper presented at the 1999 SAE Airframe/Engine Maintenance and Repair Conference. Vancouver, B.C.
5. FAA. (1997a). *Aircraft Maintenance Team Training* (Version 1.0) [CD-ROM]. Atlanta, GA: Galaxy Scientific Corporation.
6. FAA. (1997b). *Aviation Safety Action Programs* (AC-120-66). Washington, D.C.: AFS-200.
7. FAA. (1997c). *Aviation Safety Reporting Program* (AC-00-46D). Washington, D.C.: ASY-300.
8. Patankar, M., & Taylor, J. (1999). *Corporate aviation on the leading edge: systemic implementation of macro-human factors in aviation maintenance.* Paper presented at the 1999 SAE General, Corporate & Regional Aviation Meeting & Exposition. Wichita, KS.
9. Patankar, M., & Taylor, J. (In Press). *Human Resources integration master plan: a response to revolving door management.* Paper presented at the 1999 SAE Advances in Aviation Safety Conference. Daytona Beach, FL.
10. Phillips, J. (1997). *Return on Investment in Training and Performance Improvement Programs.* Houston, TX: Gulf Publishing Company.
11. Taylor, J. (In Press). *A new model for measuring return on investment (ROI) for safety programs in aviation: an example from airline maintenance resource management (MRM)*. Paper presented at the 2000 SAE Advances in Aviation Safety Conference. Daytona Beach, FL.
12. Taylor, J. C., & Christensen, T. (1998). *Airline Resource Management: Improving Communication.* Warrendale, PA: Society of Automotive Engineers.